

*E*valuation



*R*eport

THE NAVY SHIPBOARD POLLUTION CONTROL
EQUIPMENT PROGRAM

Report No. D-2001-010

November 14, 2000

Office of the Inspector General
Department of Defense

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Acronyms

APPS	Act to Prevent Pollution from Ships
CFC	Chlorofluorocarbon
EPA	Environmental Protection Agency
INSURV	Navy Board of Inspection and Survey
NAVSEA	U.S. Naval Sea Systems Command
OCM	Oil Content Monitor
ODS	Ozone Depleting Substances
OWS	Oil Water Separator
RTD&E	Research, Testing, Development, and Evaluation
SPCE	Shipboard Pollution Control Equipment



**INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202-2884**

November 14, 2000

**MEMORANDUM FOR NAVAL INSPECTOR GENERAL
DEPUTY CHIEF OF NAVAL OPERATIONS
(ENVIRONMENTAL PROTECTION, SAFETY, AND
OCCUPATIONAL HEALTH DIVISION)
COMMANDER, NAVAL SEA SYSTEMS COMMAND**

**SUBJECT: Evaluation Report on the Navy Shipboard Pollution Control Equipment
Program (Report No. D-2001-010)**

We are providing this evaluation report for your information and use. We performed the evaluation in response to a congressional request.

No written response to this report was required, and none was received. Therefore, we are publishing this report in final form.

We appreciate the courtesies extended to the evaluation staff. Questions on the evaluation should be directed to Mr. William C. Gallagher at (703) 604-9270 (DSN 664-9270) (wgallagher@dodig.osd.mil) or LTC George P. Marquardt at (703) 604-9275 (DSN 664-9275) (gmarquardt@dodig.osd.mil). See Appendix F for the report distribution. The evaluation team members are listed on the inside of the back cover.

A handwritten signature in black ink, reading "Robert J. Lieberman", is centered below the text.

Robert J. Lieberman
Assistant Inspector General
for Auditing

Office of the Inspector General, DoD

Report No. D2001-010
(Project No. D2000CB-0047)

November 14, 2000

The Navy Shipboard Pollution Control Equipment Program

Executive Summary

Introduction. This evaluation was performed in response to a congressional request contained in report no. 106-244 of the Committee on Appropriations for FY 2000. The Navy established the Navy Shipboard Pollution Control Equipment (SPCE) Program in 1995 as part of the existing Pollution Prevention Program. The focus of the program is to procure and install equipment for the disposal of waste on Navy ships. The Navy divides the program into six major elements: solid waste management, ozone depleting substance elimination, oil pollution abatement, sewage and gray water management, submarine solid waste management, and pollution prevention afloat. Multiple treaties and laws create substantive requirements which govern the major elements of the program excepting pollution prevention afloat. As of July 2000, equipment installation under the SPCE program will impact 281 active ships. To date, the Environmental Protection Systems Division of the Naval Sea Systems Command has completed 660 of 984 programmed installations, with the remaining 324 scheduled through FY 2013. The program was proceeding on schedule, and the Naval Sea Systems Command has completed 67 percent of the required work using 74 percent of the programmed funds. The Navy authorized \$635.1 million for the SPCE program through FY 2000, and programmed an additional \$259.2 million through FY 2005, for a total of \$894.3 million.

Objectives. The evaluation objective was to review the effectiveness and cost effectiveness of the Navy's pollution control equipment program for upgrading equipment on Navy ships. Specifically, the evaluation assessed the status of progress toward program goals and objectives, and reviewed program costs versus products and services delivered. In addition, the evaluation reviewed the management control program under which SPCE activities were conducted.

The mission and characteristics of Navy ships render Navy pollution control systems unique. While the Navy conducted effective alternatives analysis for program elements, we could not perform a complete cost effectiveness analysis. A detailed discussion of cost effectiveness is contained in Appendix C.

Results. The SPCE program for upgrading equipment on Navy ships was effectively meeting the stated objectives of compliance with regulatory requirements at the lowest sustainable life-cycle cost with the least operational impact. The Navy established and continued to follow installation priorities, and with 660 of 984 programmed equipment installations complete, the program was meeting scheduled production rates within the anticipated budget. Program officials acknowledged weaknesses with the operation of

the oil pollution abatement equipment and solid waste management equipment manning that continued to detract from program effectiveness.

Ship oily water discharge did not always comply with oil content standards. Sample results collected during FYs 1998 and 1999 determined that over 80 percent of the 145 ships inspected had oil content discharges greater than 15 parts per million. In response to the ineffective oil pollution abatement systems, commanding officers will not use the systems while in port or in U.S. waters. Failure to use the systems while in port has increased the strain on shore systems. The Navy is aware of changes to ship operations that caused the oil pollution abatement equipment to fail, and were testing an ultra-filtration membrane system. This process has demonstrated the ability to reliably treat discharge.

The Navy deployed solid waste management equipment without additional shipboard manpower required to operate and maintain it, then reacted slowly to the need for additional manpower. They identified a potential requirement for additional personnel in 1993, but the findings were not approved until February 1999. The Navy approved additions to the ship manning documents as a result of a Navy-directed assessment of the manpower requirement of all afloat environmental protection equipment/programs. While this is no guarantee that the Navy resource managers will fill the billets, the Naval Sea Systems Command and the fleets continue to work the issue.

The management controls that we reviewed were effective in that no material management control weakness was identified. See Appendix A for details on the management control program.

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Background

This evaluation was performed in response to a congressional request contained in report no. 106-244 of the Committee on Appropriations for FY 2000. The Inspector General, DoD, was requested to review the effectiveness and cost effectiveness of the Navy's pollution control equipment program for upgrading equipment on Navy ships. The mission and characteristics of Navy ships render Navy pollution control systems unique, ruling out proper cost effectiveness analysis. Appendix C contains a detailed discussion of cost effectiveness.

Management of The Navy SPCE Program. The Navy established the Navy Shipboard Pollution Control Equipment (SPCE) Program in 1995 as part of the existing Pollution Prevention Program. The Ship and Air Systems Branch of the Environmental Safety and Occupational Health Division of the Chief of Naval Operations, Logistics, provides program oversight. The SPCE program is managed by the Environmental Protection Systems Division of the Naval Sea Systems Command (NAVSEA). NAVSEA is responsible for all the acquisition, installation, and life cycle maintenance of all shipboard equipment. This includes systems and procedures required to manage shipboard wastes in compliance with existing and anticipated environmental restrictions worldwide without jeopardizing ship mission, survivability, or habitability.

The Navy SPCE Program The focus of the program is to procure and install equipment for the disposal of waste on Navy ships. The Navy divides the program into six major elements.

- Solid Waste Management – proper disposal of organic, inorganic, and plastic nonhazardous waste using garbage pulpers, metal and glass shredders, and plastic processors.
- Ozone Depleting Substance (ODS) Elimination – no further use and the replacement of existing chlorofluorocarbons (CFC) through air conditioning and refrigeration plant conversion.
- Oil Pollution Abatement – no discharge of liquid wastes containing more than 15 parts per million of oil, accomplished by oil water separators and verified by oil content monitors.
- Sewage and Gray Water Management – proper disposal of sewage and gray (galley, bath, and shower) water while underway through collection and storage.
- Submarine Solid Waste Management - proper disposal of organic, inorganic, and plastic non-hazardous waste using food grinders.
- Pollution Prevention Afloat – reduction in use of hazardous materials and offloads of hazardous waste with commercial and non-developmental equipment and materials.

SPCE Program Regulatory Criteria. Regulatory requirements for the SPCE program are contained in international treaties, congressional legislation, and executive orders. Multiple treaties and laws create substantive requirements

which govern the major elements of the program excepting pollution prevention afloat. Substantive requirements create, define, and regulate rights and duties of parties.

International Conventions. The International Convention for the Prevention of Pollution from Ships (MARPOL Protocol), February 17, 1978, is the international treaty designed to protect the marine environment from pollution by ships. Annex I establishes the requirements for oil pollution at sea and delimits “special areas” for discharges. Annex V establishes shipboard and submarine solid waste discharge requirements. The MARPOL Protocol was ratified by Congress and substantive requirements are incorporated in legislation.

The Montreal Protocol on Substances that deplete the Ozone Layer (Montreal Protocol), September 16, 1987, is the international treaty designed to protect the stratospheric ozone layer. The Montreal Protocol controls the production and use of controlled substances and specifically establishes a phase out schedule for CFCs, Halons, and other ozone depleting substances. The Montreal Protocol was ratified by Congress and compliance with requirements are contained in legislation.

Congressional Legislation. Specific criteria clauses control the minimization of air and water pollution through the proper handling and disposal of waste aboard Navy vessels. The Navy is not exempt from following regulatory guidelines for the type and volume of discharges within stated permissible areas, or meeting compliance deadlines. A comprehensive listing of criteria for each program element is contained in Appendix B.

Executive Order. Executive Order No. 12,088, Fed. Reg. 47,707 (1978) states that “all necessary actions should be taken for the prevention, control, and abatement of environmental pollution.” In addition, the order states that “the head of each Executive agency is responsible for compliance with applicable pollution control standards . . . meaning the same substantive, procedural, and other requirements that would apply to a private person.”

Equipment Installed to Date. As of July 2000, equipment installation under the SPCE program will impact 281 active ships. An installation is defined for this report as all like pieces of equipment placed in a single ship. To date, NAVSEA has completed 660 of 984 programmed installations, with the remaining 324 scheduled through FY 2013. The Assistant Secretary of the Navy for Installations and the Environment established installation priorities for the program in 1994, based on the effective dates of legislation, the status of current ships’ equipment, and maintenance schedules. The program is proceeding on schedule, and NAVSEA has completed 67 percent of the required work using 74 percent of the programmed funds. Equipment installation or conversion status varies by and within the program element. For example, the installation of solid waste equipment on surface ships is over 92 percent complete, while the submarine solid waste equipment installation will not begin until FY 2001. Detailed program information is contained in Appendix D.

Program Resources. Table 1 shows that the Navy has authorized NAVSEA \$635.1 million for the SPCE program through FY 2000. NAVSEA has programmed an additional \$259.2 million through FY 2005, for a total of \$894.3 million. The SPCE program is part of the Navy's afloat environmental quality program. The afloat environmental quality program includes funding from Operations and Maintenance, Navy (Environmental Compliance), and Other Procurement, Navy, line items 093500 (SPCE) and 093505 (SPCE Installation). A comparison between yearly authorization and expenditures shows virtually no migration of funds in or out of the program.

Table 1. Program Funding and Execution (in millions)						
<u>FY</u>	<u>Funds Appropriated</u>	<u>NAVSEA Authorized</u>	<u>NAVSEA Obligated</u>		<u>NAVSEA Expended</u>	
1995	\$ 62.9	\$ 64.5	\$ 64.3	99.7%	\$ 63.7	98.8%
1996	104.5	102.1	101.9	99.8%	99.7	97.5%
1997	130.2	123.8	123.7	99.9%	121.7	98.3%
1998	172.9	113.3	112.5	99.3%	109.5	96.7%
1999	156.4	117.0	107.9	92.2%	85.2	72.8%
2000	<u>116.5</u>	<u>114.4</u>	<u>36.0</u>	31.5%	<u>3.3</u>	02.9%
Total	\$743.4	\$635.1	\$546.3		\$483.1	

Objectives

The evaluation objective was to review the effectiveness and cost effectiveness of the Navy's pollution control equipment program for upgrading equipment on Navy ships. Specifically, the evaluation assessed the status of progress toward program goals and objectives, and reviewed program costs versus products and services delivered. In addition, the evaluation reviewed the management control program under which SPCE activities were conducted. See Appendix A for a discussion of the evaluation scope and methodology, our review of the management control program, and a summary of prior audit coverage related to the evaluation objectives.

Navy SPCE Program Effectiveness

Although the Navy SPCE program met stated objectives, program officials acknowledged the following weaknesses that continued to detract from program effectiveness.

- Ship oily water discharge did not always comply with oil content standards.
- The Navy deployed solid waste management equipment without additional shipboard manpower required to operate and maintain it.

These problems occurred because of inefficient installation, improper maintenance, bilge water discharge process changes, inefficiencies in the manpower assessment system, and ineffective staff coordination by the Navy. This situation resulted in the risk of environmental contamination, compliance fines, a negative impact on sailor morale, and increased equipment failure rates.

SPCE Program Effectiveness

Overall Program Effectiveness. NAVSEA, through the SPCE program, provided the Navy with a standardized approach and centralized equipment procurement, which allowed individual naval vessels to stay in compliance with environmental regulations governing ships at port and underway. We identified no fines, violations, or port bans to date as a result of SPCE use or failure. The Navy SPCE program met stated objectives.

Program Goal and Strategy. The SPCE Program goal was unencumbered operation worldwide in compliance with environmental laws and regulations. The program strategy was designed to meet essential Level 1 compliance requirements with the least operational impact at the lowest sustainable life-cycle cost. Level 1 compliance requirements are derived from existing laws, regulations and Executive Orders that applied to Navy organizations, platforms and operations.

Compliance Requirements

Regulatory Requirements. The Navy used three methods to meet regulatory requirements: new equipment and processes, phase out of existing equipment, and equipment buyout. New equipment and process designs were necessary for solid waste management and the air conditioning and refrigerant portion of the ODS conversion. Technological constraints necessitated a phase out for nonplastic submarine solid waste management and ship Halon 1301 fire fighting system conversion. The sewage and gray water and oil pollution abatement

programs were ongoing, needing only an equipment buyout. The following table summarizes Navy compliance status through September 2000.

Table 2. Navy Pollution Control Compliance Status			
<u>SPCE Program Element</u>	<u>Compliance Date</u>	<u>Compliance Status</u>	<u>Comments</u>
Solid Waste			
Plastics discharge	Dec. 31, 1998	Standard MET	
Other solid waste	Dec. 31, 2000	Standard MET	9 Ships programmed for FY 2001
Ozone Depleting Substances			
Chloroflouorocarbons	Jan. 1, 1996	Standard MET	Ozone Depleting Substance production ban met.
Halon 1301	Jan. 1, 1994		Consumption extended until ship decommissioning by Exec. Order
Oil Pollution Abatement			
Oil water separation	Jun. 14, 1995	Substantially MET	30 Ships remaining
Discharge oil content	Oct. 1, 2000	Standard MET	
Sewage and Grey Water	Jan. 30, 1980	Standard MET	
Submarine Solid Waste	Dec. 31, 2008	Programmed	Start during FY 2001
Pollution Prevention Afloat	Not Applicable		Program not compliance driven

New Equipment and Process Design. MARPOL Protocol Annex V establishes distinct requirements for plastics, inorganic wastes, and organic wastes. Office of the Chief of Naval Operations Instruction 5090.1b, "Environmental and Natural Resources Program Manual," dated February 2, 1998, effectively transfers the requirements into Navy regulations. The Navy also designed and installed various pieces of equipment in order to meet these requirements.

- To meet the plastics discharge prohibition while at sea, the Navy took a four step approach: source reduction, segregation, volume reduction, and retrograde. The plastic waste processor melts and compresses plastic waste into disks at a 30:1 volume reduction. The disks are vacuum packed for storage on board.
- Ships may discharge inorganic wastes with negative buoyancy outside of 12 nautical miles from land. Sailors shred metal and glass, pack the waste in burlap bags, and discharge them overboard.
- Ships may discharge organic wastes that pass through a 12 millimeter screen. NAVSEA installed equipment that pulps paper, cardboard, and food waste with seawater into a slurry with a particle size less than 12 millimeters.

The Montreal Protocol called for the phase out of the production and consumption of substances that deplete the stratospheric ozone layer. Navy ships are large consumers of CFC-12 and CFC-114, used in air conditioning and refrigeration systems. While exempted from the specific dates of the phase-out schedule, the Navy has addressed the use of CFCs by adopting suitable refrigerant substitutes, purchasing conversion kits for existing equipment, and establishing an ODS reserve for use until final phase out. The replacement of CFC-12 with HFC 134a, and CFC-114 AC with HFC-236fa, allowed existing ships to maintain operation. NAVSEA continues to develop new non-ODS equipment for new ship construction.

Phase Out. Congress extended requirement deadlines for Submarine Solid Waste Management until December 2008, and by Executive Order for Halon 1301 consumption until ship decommissioning. The Navy analyzed numerous options and concluded that full compliance with MARPOL Protocol Annex V standards was not “reasonable and practicable” because of the unique space, weight, and operational constraints on existing submarines. Submarines will follow the plastic discharge prohibition, and NAVSEA has programmed the installation of garbage grinders.

Consumption of Halon 1301 continues in ship fire fighting systems. The Navy has not yet identified a suitable chemical replacement, and system conversion is not feasible. Existing ships will continue using Halon 1301 in this critical system until decommissioning. NAVSEA will equip new vessels with water mist and HFC-227ea systems.

Equipment Buyout. The standards and chosen solution for sewage and gray water and oil pollution abatement equipment predate the SPCE program. NAVSEA used SPCE funds to purchase remaining equipment for ships not outfitted prior to 1995. The Clean Water Act, section 1251-1374, title 33, United States Code, promulgates Federal standards to prevent the discharge of untreated or inadequately treated sewage into navigable waters from vessels. Ships’ systems, including the use of U.S. Coast Guard-certified Marine Sanitation Devices, meet discharge requirements. MARPOL Protocol Annex I established a limit for the oil content of discharge water at 15 parts per million in 1978. The Navy’s oil water separators and oil content monitors are generally capable of meeting the standard. However, process changes generate highly contaminated bilge water beyond the capabilities of the equipment.

Oily Water Discharge. Ship oily water discharge did not always meet compliance standards for oil content. For example, Navy Board of Inspection (INSURV) sample results collected during FYs 1998 and 1999 determined that 82 percent and 86 percent, respectively, of the 145 ships inspected had discharges with an oil content greater than 15 parts per million. The oil pollution abatement system consists of a commercial bulk oil water separator and a U.S. Coast Guard-approved commercial oil content monitor; both pieces of equipment contributed to the failure to achieve standards.

Equipment Adequacy. The ships’ discharge failed to meet standards because of inefficient installation, improper maintenance, and bilge water

discharge process changes. In a few cases, NAVSEA installed the oil water separator in a location that made it very difficult to remove the cover. This inhibited proper maintenance and cleaning. Also, ships' personnel continued to use nonapproved emulsion agents during bilge tank cleaning which contaminated and fouled oil water separators.

The overwhelming majority of failures were caused by bilge water discharge process changes. The parallel plate technology used in the oil water separators was designed in the 1970s to filter bilge water containing low concentrations of oil and contaminants. Since then, because of improved ship design and changed management practices, bilge water generally has concentrations of contaminants over 215 parts per million. While a properly functioning oil water separator removed 93 percent of contaminants, the high initial concentration meant the oil content of the discharge remained over the 15 parts per million standard. Also, INSURV reported that oil content monitors were generally unreliable. During their inspections, 36 of 43 ship oil pollution abatement installations failed certification, primarily because of deficiencies in the oil content monitors.

Contamination and Fines. As a result of equipment failures, there is a risk of environmental contamination and compliance fines against the Navy. In response to the failure of more than 80 percent of the oil pollution abatement systems, commanding officers will not use the systems while in port or in U.S. waters. Failure to use the systems while in port has increased the strain on shore systems. While commanding officers are not personally liable for contamination, oil spills have led to environmental fines against Naval installations and degraded public relations.

Navy Solution. The Navy is testing an ultra-filtration membrane system. This process uses filtration of discharge water through an ultra fine membrane following the existing oil water separators, and has demonstrated the ability to reliably treat discharge. NAVSEA plans to backfit existing systems, and plans to submit for funding in the FY 2003 budget. NAVSEA is developing a smaller, lower maintenance combined system for new ship construction.

Operational Impacts

Operational Impact. NAVSEA effectively minimized the operational impact to the fleet of the SPCE program. Achieving compliance has caused several operational improvements, as well as minor negative impacts. NAVSEA minimized impact to fleet operations by performing equipment installation during scheduled maintenance periods. Specifically, NAVSEA chose equipment that caused the least physical disruption on the ship while attempting to keep operation and maintenance as simple as possible.

The addition of the SPCE equipment caused minor operational improvements. The installation of the ODS conversion kits included control system enhancements which improved reliability and reduced maintenance requirements. Also, the replacement of CFC-114 with HFC-236fa in ship air conditioning plants allowed ships to operate in areas with higher air temperature while generating a

lower acoustic signature. Finally, the addition of the pollution prevention afloat equipment, specifically the cable degreaser and the mercury ion exchange cartridge system, saved many man-hours.

The on board equipment suite also caused minor operational problems. Periodic failures of the oil pollution abatement system have caused ship commanders to routinely turn the system off while in port. This necessitates hook up to a shore disposal facility that can handle oily water, or retention on board for the duration of the port visit. Also, ships must be at least 12 nautical miles from shore to use the inorganic waste shredder and 3 nautical miles to use the organic pulper, forcing on board storage when the ship is required to remain anchored in inland waters for extended periods. Solid waste management in general was a new operation for ships' personnel.

Shipboard Manpower. The Navy deployed solid waste management equipment without additional shipboard manpower required to operate and maintain it. The addition of the plastic waste processors, shredders, and garbage pulpers generated a labor-intensive process. Proper use of on board equipment requires waste segregation, hand delivery to the equipment, processing, and equipment clean up, where previously trash and garbage was dumped overboard. This means that there were no personnel offsets available from existing billets. NAVSEA began solid waste management equipment installation on surface ships in 1996, and will finish in 2001.

Manpower Assessment Process. The manpower shortages occurred because of ineffective staff coordination by the Navy and inefficiencies in the manpower assessment system. NAVSEA was responsible for development, procurement, and fielding of the equipment, while the Navy Manpower Analysis Center evaluated labor requirements and developed ship manning documents.

The Navy reacted slowly to the need for additional manpower. NAVSEA identified a potential requirement for additional personnel in 1993. The manpower analysis for the plastic waste processor was not conducted until 1998, and the findings were not approved until February 1999. While the Navy requires revalidation of ship manning documents every 2 years, equipment installation is a continuous process. The initial entry of an additional manpower requirement potentially lags equipment installation by 2 years. Finally, the ship manning document reflects wartime requirements. Reduced authorizations, personnel transition, and other factors only allow resource managers to fill 90 percent of requirements.

Morale and Equipment Impacts. These problems have resulted in a negative impact on sailor morale, increased equipment failure rates, and the risk of environmental contamination and compliance fines. Because of the lack of dedicated manpower for the equipment, operation and maintenance was a temporary assignment for junior personnel. While underway, crewmembers improperly segregated waste, forcing the operator to sort bags of trash and food waste prior to using the pulper. Sailors considered equipment operation an unpleasant burden, which negatively impacted morale.

Ship crews rotated solid waste equipment operations among sailors, some of whom were improperly trained. Ships' personnel report a ratio of three cleaning and maintenance hours per hour of operation for the plastic waste processor. INSURV inspections verified that operators were not cleaning the equipment properly. This led to failure rates doubling for this piece of equipment. Also, overall inadequate manning caused ships' personnel to use the equipment infrequently, adding to maintenance problems. Infrequent use resulted in the ship storing garbage, creating possible health and sanitation hazards.

Navy Solution. The approved additions to the ship manning documents were a result of a Navy-directed assessment of the manpower requirement of all afloat environmental protection equipment/programs. Based on observations of fleet use of the equipment and planned maintenance schedule requirements, the Navy determined that numbers produced by the study were reasonable and correlated to the 1993 NAVSEA study. The Navy Surface Fleet, Atlantic, verified that the Navy Manpower Analysis Center intends to upload the manpower requirements for the Program Operating Memorandum for FY 2002. While this is no guarantee that the Navy resource managers will fill the billets, NAVSEA and the fleets continue to work the issue.

Lowest Sustainable Life-Cycle Cost

Minimizing Equipment Life-Cycle Costs. NAVSEA defines life-cycle costs as research, development, testing, and evaluation (RDT&E), production, installation, maintenance and support, and disposal costs. NAVSEA uses SPCE program funding for procurement and installation costs, and is responsible for RDT&E using other than SPCE program funds. Different Navy commands manage maintenance and support and disposal costs.

To minimize procurement costs, NAVSEA purchased commercial or non-developmental products where possible. The oil pollution abatement, sewage and gray water, and pollution prevention afloat equipment were all examples of commercial equipment purchased using competitively bid contracts. Because of the lack of a commercial alternative, NAVSEA designed the solid waste management equipment for both surface ships and submarines, while the production contract were competitively bid. In the case of the ODS systems, either the original equipment manufacturer was the only company with knowledge of the systems, or still owned the data rights. NAVSEA chose a sole source contract for the development of the conversion kits.

NAVSEA minimized installation costs through proper design and planning. They ensured that lessons learned from initial equipment installations were disseminated to all facilities performing the work. In addition, during RDT&E, NAVSEA worked toward minimizing both procurement and installation costs. The criteria used during alternative analysis prior to equipment design and procurement included purchase, installation, operation, maintenance, and sailor labor costs.

Future Requirements. Anticipating and influencing future requirements was not a stated objective of the SPCE program. However, the Navy's active response in the development of solid waste management standards and the Uniform National Discharge Standards contributed to program effectiveness and reduced program life-cycle costs.

The Navy was actively involved in the development of solid waste management standards. MARPOL Protocol and its enabling U.S. legislation, the Act to Prevent Pollution from Ships (APPS), sections 1901-1911, title 33 United States Code, did not strictly apply to warships. In response to pending legislation, the Navy developed a Shipboard Solid and Plastics Waste Management Program Plan in 1987 that called for plastic discharge reduction within 5 years and full compliance with MARPOL Protocol Annex V within 11 years. Congress enacted the Marine Plastic Pollution Research and Control Act, section 1901, title 33 United States Code, requiring full compliance within 5 years. In 1993, the Navy issued a report to Congress asking for a 6 year extension for surface ships. Congress agreed to the deadline extension and codified the standards with the National Defense Authorization Act for Fiscal Year 1994. This Act extended the compliance date for solid waste discharges to 1998, the original date stated in the 1987 plan.

The Navy took a proactive role in the development of the Uniform National Discharge Standards. This joint initiative between DoD and the Environmental Protection Agency (EPA) determined which uncontrolled discharges required standards. Developing the standards was a three step process: identify discharges requiring control, evaluate control devices and set standards, implement regulations. The Navy participated as a full partner in phases one and two, to assure their concerns were addressed.

Summary

The SPCE program for upgrading equipment on Navy ships was effectively meeting the stated objectives of compliance with regulatory requirements at the lowest sustainable life-cycle cost with the least operational impact. The Navy established and continued to follow installation priorities, and with 660 of 984 programmed equipment installations complete, the program met scheduled production rates within the anticipated budget. NAVSEA was aware of changes to ship operations that caused the oil pollution abatement equipment to fail, and were testing solutions to the problem. The addition of the solid waste management equipment created a manpower requirement, which the personnel managers were attempting to resolve. Overall, the program contributed to the Navy's goal of unencumbered operations worldwide in compliance with environmental laws and regulations. Because problems in the program are being addressed and no material management control weaknesses were identified, we are not making recommendations in this report.

Appendix A. Evaluation Process

Scope

We reviewed the effectiveness and cost effectiveness of the Navy's shipboard pollution control equipment program for upgrading equipment on Navy ships. Specifically, we reviewed the status of progress toward program goals and objectives, program costs versus products and services delivered, and the management control program as it applies to the other stated evaluation objectives.

DoD Functional Area Reform Goals. Most DoD functional areas have also established performance improvement reform objectives and goals. This report pertains to achievement of the following functional area objective and goal:

Environmental Functional Area. Objective: Achieve compliance with applicable Executive orders and Federal, State, and inter-state, regional, and local statutory and regulatory environmental requirements. **Goal:** Number of new, open, unresolved, and closed enforcement actions applicable environmental statutes. (ENV-2.1)

General Accounting Office High-Risk Area. The General Accounting Office has identified several high-risk areas in the DoD. This report provides coverage of the Defense Financial Management high-risk area.

Methodology

To accomplish the evaluation, we reviewed U.S. law, Executive Orders, and policies and guidance from DoD and the Navy. We also reviewed the adequacy and effectiveness of existing Navy policies, guidance, and plans used to implement the SPCE Program at Naval installations. We:

- conducted site visits to selected Naval ships and facilities;
- reviewed FY 1995 through FY 2005 budget and execution data, and interviewed key environmental personnel to determine how Naval installations spent SPCE Program funds;
- interviewed ship personnel to obtain their views on the effectiveness of the program;

-
- interviewed management control officials to identify controls relating to the SPCE Program and reviewed management's self-evaluation processes; and
 - interviewed environmental management officials from the cruise line industry to determine their methods for pollution control.

Evaluation Type, Dates, and Standards. We performed this economy and efficiency evaluation from January 2000 through July 2000 in accordance with standards implemented by the Inspector General, DoD. Accordingly, we included tests of management controls considered necessary. We did not rely on computer-processed data or statistical sampling procedures.

Contacts During the Evaluation. We visited or contacted individuals and organizations within DoD and the civilian cruise line industry. Further details are available on request.

Management Control Program Review

DoD Directive 5010.38, "Management Control (MC) Program," August 26, 1996, and DoD Instruction 5010.40, "Management Control (MC) Program Procedures," August 28, 1996, require DoD organizations to implement a comprehensive system of management controls that provides reasonable assurance that programs are operating as intended and to evaluate the adequacy of the controls.

Scope of Review of the Management Control Program. We reviewed the adequacy of management controls over the implementation of the SPCE program. Specifically, we reviewed the adequacy of management controls over equipment procurement, installation, and operation. Because we did not identify a material weakness, we did not assess management's self-evaluation.

Adequacy of Management Controls. Management controls for implementing the SPCE program and managing equipment were adequate as they applied to the evaluation objectives.

Prior Coverage

The General Accounting Office has issued Report No. NSIAD-95-38, "Pollution Prevention: The Navy Needs Better Plans for Reducing Ship Waste Discharges," November 11, 1994, discussing the SPCE program.

Appendix B. SPCE Program Criteria

Navy vessels must be in full compliance with the following criteria, so far as is reasonable and practicable without impairing the operations or operational capabilities of such ships.

Solid Waste

Section 1902 of APPS requires U.S. vessels, including warships, to comply with MARPOL Protocol Annex V shipboard and submarine solid waste discharge requirements by established deadlines.

Effective Date. Surface ships must be in full compliance with APPS provisions for solid waste by December 31, 1998 and by December 31, 2000 in special areas (a sea area where, for recognized technical reasons, in relation to its oceanographical and ecological condition and to the particular character of its traffic, the adoption of special mandatory methods for prevention of sea pollution by garbage is required).

Substantive Law. Ships are prohibited from discharging pollutants within 3 nautical miles of shore. Navy ships with plastic waste processors are prohibited from discharging any plastics. Those ships without plastic waste processors must follow the 3-day/20-day rule. Surface ships shall not discharge:

- food contaminated plastics the last 3 days at sea, and
- nonfood-contaminated plastics the last 20 days at sea.

Ships outside of special areas may discharge nonplastic wastes able to pass through a 25 millimeter screen between 3 and 12 nautical miles, nonfloating waste beyond 12 nautical miles, and floating waste beyond 25 nautical miles from shore. Ships within special areas can discharge waste able to pass through a 12 millimeter screen outside 3 nautical miles and metal and glass that have been shredded and bagged to negative buoyancy outside 12 nautical miles.

Ozone Depleting Substances

The Clean Air Act, sections 7401-7671, title 42, United States Code is a comprehensive Federal law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the EPA to establish National Ambient Air Quality Standards to protect public health and the environment. Section 7671m applies subchapter VI, "Stratospheric Ozone Protection," as a supplement to the terms and conditions of the Montreal Protocol.

Effective Date. Navy vessels must be in full compliance Clean Air Act provisions for ODS. The production phase-out schedule of ODS is: halons by

December 31, 1993; CFCs, methylchloroform, and carbon tetrachloride by December 31, 1995; and Class II substances by 2030.

Substantive Law. The Navy has not met the above phase-out schedule for CFCs and halons because the established dates were not technically feasible. Exec. Order No. 12,843, 58 Fed. Reg. 77 (1993), implements an extension for the phase-out of CFCs and halons through Section 7418 of the Clean Air Act. DoD Directive 6050.9, "Chlorofluorocarbons and Halons," February 13, 1989, establishes the DoD ODS reserve for mission critical applications.

Oil Pollution Abatement

Section 1902d of APPS requires U.S. vessels, including warships, to comply with MARPOL Protocol Annex I oil pollution requirements at sea.

Effective Date. Navy vessels must be in full compliance with the 1990 amendments to APPS provisions for oil pollution abatement.

Substantive Law. Oil content of discharges from all ships can not exceed 15 parts per million. In special areas, discharge of oil or oily mixture from oil tankers and other ships in excess of 400 gross tons is prohibited. However, discharge of processed bilge water from machinery spaces is allowed if the following conditions are met:

- the ship is proceeding en route, and oil content of the overboard discharge without dilution does not exceed 15 parts per million;
- ship has in operation oil filtering equipment that will alarm if an output of greater than 15 parts per million is exceeded;
- and the filtering system is equipped with a stopping device that will ensure that the discharge is automatically stopped if the effluent oil content exceeds 15 parts per million.

Uniform national discharge standards requires the EPA and DoD to identify and evaluate currently non-regulated discharges from Armed Forces vessels. Uniform national discharge standards is broken down in the following three phases, with phase 2 currently underway:

- (Phase 1) DoD and EPA determined 25 of the 39 discharges identified require a Marine Pollution Control Devices;
- (Phase 2) Evaluation of candidate Marine Pollution Control Devices and establishment of performance standards; and,
- (Phase 3) Develop implementing regulations.

Sewage and Gray Water

Section 1322 of the Clean Water Act directs the EPA, Coast Guard, and States to work together to protect human health and the aquatic environment from disease-causing microorganisms which may be present in sewage from vessels. This section also provides states with a tool to protect their citizens and aquatic habitats through standards for Marine Sanitation Devices and no-discharge zone designations for vessels.

Effective Date. Navy vessels must be in full compliance with 40 C.F.R. Section 140 (1976), provisions for Sewage and Gray Water by January 30, 1977 for new vessels and January 30, 1980 for existing vessels. DoD Directive 6050.4, "Marine Sanitation Devices for Vessels Owned or Operated by the DoD," March 16, 1982, implements these provisions.

Substantive Law. Vessels constructed before January 31, 1980, and equipped with a Type I Marine Sanitation Device shall not produce a fecal coliform bacterial count greater than 1,000 per 100 milliliters or visible floating solids. Vessels constructed after January 31, 1980 or equipped with a Type II Marine Sanitation Device shall not produce a fecal coliform bacterial count greater than 200 per 100 milliliters or suspended solids greater than 150 mg/l.

Submarine Solid Waste

The criteria for submarine solid waste is the same as the criteria for solid waste listed above with minor exceptions.

Effective Date. Submarines must be in full compliance with APPS provisions by December 31, 2008.

Substantive Law. Submarines are prohibited from discharging pollutants within 3 nautical miles of shore. Outside of 3 nautical miles, submarines with plastic waste processors are prohibited from discharging any plastics or buoyant garbage. Within special areas, submarines may discharge waste able to pass through a 12 millimeter screen outside 3 nautical miles, metal and glass that have been shredded and bagged to negative buoyancy, and nonplastic garbage that has been compacted and weighted to ensure negative buoyancy outside 12 nautical miles from land.

Pollution Prevention Afloat

Exec. Order No. 12,856, 58 Fed. Reg. 41,981 (1993) directs the Federal Government to demonstrate pollution prevention leadership by improving facility management, incorporating environmental principles in acquisition practices, establishing pollution prevention goals and plans, and developing innovative technologies. DoD Instruction 4715.4, "Pollution Prevention," June 18, 1996 implements policy, assigns responsibility, and prescribes

procedures for implementation of pollution prevention programs throughout the DoD under DoD Directive 4715.1, "Environmental Security," February 24, 1996.

Effective Date. There is no compliance date for this area of the program.

Substantive Law. Pollution prevention plans should be developed which support cost-effective environmental compliance, achievement of DoD measure of merit goals, reduce generation of pollutants, and or reduce the overall life-cycle cost of the activities environmental program.

Appendix C. Evaluation of Cost Effectiveness

We determined that a proper analysis of program cost effectiveness was not feasible. Analysis of cost effectiveness requires alternative actions or systems for comparison using cost and effectiveness as variables. The Navy has conducted alternatives analysis for individual elements of the SPCE. However, while other ship owning organizations have equivalent environmental protection goals, their systems are distinctly different from the Navy. These dissimilarities prohibit a comparison of the program as a whole.

Cost Effectiveness. A determination of cost effectiveness requires comparison. In his text, Quade¹ provides the following definition:

Cost effectiveness is a form of systems analysis in which the alternative actions or systems under consideration are compared in terms of two of the consequences, dollar or resource costs and the effectiveness, associated with each alternative. The effectiveness of an alternative is measured by the extent to which that alternative, if implemented, will attain the desired objective.

Using this definition, alternative actions or alternative systems for comparison are necessary in order to conduct a cost effectiveness analysis for the SPCE program. The Navy has considered alternative actions throughout their development and execution of the program.

Alternatives Analysis. Prior to purchasing equipment for the program, the Navy conducted research and analysis. These efforts were funded under PE63721N, "Environmental Protection," project S0401, "Shipboard Waste Management", not from SPCE authorizations.

Ship and Submarine Solid Waste. Prior to deciding on the current suite of equipment, the Navy conducted a comprehensive study. The results are summarized for surface ships in the November 1996 report to Congress, and for submarines in the December 1997 report. Both analyses identified and evaluated multiple options against well defined criteria including cost and effectiveness.

Ozone Depleting Substances. Regulations require the Navy to eliminate three ozone depleting substances: CFC-12 used in reciprocating-compressor air-conditioning and refrigeration equipment, CFC-114 used in centrifugal-compressor air-conditioning plants, and Halon used in fire-fighting systems. They determined that replacing all existing systems was cost prohibitive. Analysis of the engineering effectiveness and cost of alternatives was different in all three cases.

¹"Analysis for Public Decisions," by E.S Quade, Elsevier Press, New York, 1979, p. 25

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- Major chemical manufacturers provided HFC-134a as a replacement for CFC-12. NAVSEA tested and began conversions of existing systems.
 - Due to the limited commercial market for CFC-114, NAVSEA conducted an engineering analysis and chose HFC-236fa to replace CFC-114. They then tested and began conversions of existing systems.
 - Due to the lack of viable alternatives, the Navy chose to continue to use Halon in existing ships until decommissioning.

For new ship construction, the Navy will also use HFC-134a for all air conditioning and refrigeration applications, while water mist and HFC-227ea systems will replace Halon.

Oil Pollution Abatement. The Navy considered existing equipment alternatives in the initial selection of oil water separators (OWS) and an oil content monitors (OCM). The parallel plate gravity coalescence technology currently in use by the Navy in OWS was selected as a result of research and development in the late 1970's and is beyond the scope of this project. The OCM technology was selected following the evaluation of several existing, USCG certified equipment types. Due to self-identified effectiveness problems, the Navy is currently studying new technology to achieve current effluent discharge requirements.

Sewage and Gray Water. The Navy designed their collection systems in order to meet requirements at the least possible cost. Due to the variety of ages, sizes, and missions of surface ships, the Navy has built several alternatives. All existing alternatives meet current regulations. Alternatives attempted include gravity flow combined systems, separate systems, and separate vacuum-incinerator sewage systems. While the Navy updates technology on newer ships, current regulations do not demand options other than overboard disposal.

Pollution Prevention Afloat. Based on analysis of a ship's process pollution prevention assessment, NAVSEA identified 16 opportunities for testing on the USS John Hancock. The opportunities were primarily commercial off-the-shelf equipment and non-developmental items. Using cost, return on investment, effectiveness, and other qualitative criteria, and following an underway testing period, NAVSEA chose nine opportunities for transition to all SPRUANCE-Class ships.

Systems Comparison. While both the Cruise lines and the Navy operate surface ships, their mission, methodology, and operational constraints are significantly different. Many of the pollution control processes they use are similar, but there are too many differences to allow for a system wide cost effectiveness comparison.

The Cruise lines operate one type of vessel for the purpose of passenger recreation, carrying from 900 to 2600 passengers and crew. The ships are normally underway for a minimum of 3 to a maximum of 14 days between port

calls, and are not designed for weather extremes. Virtually all ship maintenance is done in port by shore based personnel. The vessels tend to be only a few years old.

The Navy operates many different types of ships, carrying crew complements from several hundred to more than 5000. They require ships to sustain operations at sea for long periods, operate in harsh physical environments, and sustain performance in combat environments. Because of the combat mission, weight and space are at a premium during ship design. Navy personnel perform most of the repairs onboard, so equipment must require minimum maintenance.

The following table summarizes the differing equipment chosen by both organizations to meet current regulatory requirements.

Pollution Control Methodology and Equipment				
<u>SPCE Program Element</u>	<u>Navy</u>		<u>Cruise Lines</u>	
	<u>Process</u>	<u>Equipment</u>	<u>Process</u>	<u>Equipment</u>
Solid Waste				
Plastics	Volume reduction, Shore disposal	PWP	Shore disposal	None
Organic Waste	Grind to slurry, Dispose	Pulper	Burn, Shore disposal of ash	Incinerator
Inorganic Waste	Shred, Dispose	Shredder	Shore disposal	Shredder
Ozone Depleting Substances				
Existing Systems	Conversion Kits	HFC-134a	Limited conversion	HFC-134a
		HFC-236fa	Most ships constructed with HFC-134a	HFC-236fa
		Halon		Halon
New Construction	Design	HFC-134a	Design	HFC-134a
		Water Mist		Water Mist
Oil Pollution Abatement	Parallel plate, Gravity separation	OWS/OCM	Parallel plate, Gravity separation	OWS/OCM
Sewage and Grey Water	None	Combined Tanks	Biological Treatment	Separate Tanks
Submarine Solid Waste	Grind to slurry	Grinder	N/A	N/A
Pollution Prevention Afloat	Reduction	Various	N/A	N/A

Solid Waste. The solid waste processes differ greatly. The Navy conducts volume reduction on plastic waste because of the length of operations at

sea and lack of storage space. The cruise lines do not have this requirement. The cruise lines incinerate organic waste. The Navy, due to installation costs and space and weight constraints, selected the pulp and dispose alternative. Both organizations shred inorganic waste, and dispose of it in accordance with regulations.

Ozone Depleting Substances. Both organizations chose a similar approach to ODS elimination. They converted existing CFC-12 systems to HFC-134a, and use or plan to use HFC-134a for all new construction. The Navy also has to convert CFC-114 systems to HFC-236fa. Both also chose to continue using existing Halon fire fighting systems, and to use combination water and HFC-227ea based systems for all new construction.

Oil Pollution Abatement. Virtually all ships use a parallel plate OWS/OCM combination. Both organizations are planning system upgrades. One cruise line has already adopted centrifuge technology, while the Navy is testing membrane filtration.

Sewage and Gray Water: All cruise line vessels separate sewage and gray water. They hold the water while the ships are in port, and dispose when underway. Sewage is collected using a vacuum system, and treated using biological processes prior to disposal. The Navy uses a gravity flow, combined sewage and gray water, collection holding tank system on the majority of their ships. Ships use shore side disposal while in port, and discharge overboard while underway. Differences are primarily due to the greater age of the Navy vessels.

Submarine Solid Waste and Pollution Prevention Afloat: Neither of these program elements apply to the cruise lines. Pollution prevention afloat opportunities are focused on maintenance practices, and the cruise lines conduct shore based maintenance only. No comparison is possible.

While some of the equipment and processes are the same, the overall systems for pollution control used by the cruise lines and the Navy are dissimilar. Both accomplish oil pollution abatement using an OWS/OCM combination, use HFC-134a as the replacement for ozone depleting chemicals, and retrograde all hazardous waste. However, unique mission requirements led the Navy to entirely different solid waste equipment and processes. The extended service life of their ships caused the Navy to convert all ozone depleting chemical systems. The relatively newer ships of the cruise lines have treatment systems for sewage, while Navy ships combine and discharge.

While the Navy conducted effective alternatives analysis for program elements, we could not perform a complete cost effectiveness analysis. The Navy and the cruise lines' pollution control programs have significant system process and equipment differences. These differences, combined with the variety in age, size, and primary mission of Navy ships versus the cruise lines, prohibit a proper cost effectiveness analysis between the systems.

Appendix D. NAVSEA Installation Data

Using funding from the SPCE program, the Navy has programmed the purchase of quantities of 11 different pieces of equipment, 3 conversion kits, and 2 equipment suites for installation in 281 active vessels. An installation is defined for this report as all like pieces of equipment placed in a single ship. Data from the installation of 9 pieces of equipment and the 3 conversions, accounting for over 92 percent of program expenditures, is summarized below.

Equipment Installation versus Dollars Expended

Table 1 summarizes installations completed through the third quarter of FY 2000 and those planned versus expenditures. None of the equipment or conversions are required on all 281 ships, and no single ship requires all installations. The timing of the installations reflect official Navy priorities established in 1994, effective dates for compliance, and ship maintenance availability. The timing of expenditures track installations as expected. The data shows that NAVSEA has completed 660 out of 984 programmed installations (67 percent) for the items shown. They have completed 67 percent of the required installations using 74 percent (\$605 Million) of programmed funds.

Table 1. Programmed Installations and Expenditures						
<u>Equipment Type</u>	<u>Installations</u>			<u>Expenditures</u>		
	<u>Total to date</u>	<u>4th Q FY 2000+</u>	<u>Program total</u>	<u>Total to date</u>	<u>4th Q FY 2000+</u>	<u>Program total</u>
Plastic waste processor	186	1	187	\$230.8	\$ 0	\$230.8
Pulpers and shredders	143	26	169	226.0	1.7	227.7
Oil water separators	28	2	30	52.3	5.1	57.4
Oil content monitors	55	8	63	8.4	0.3	8.7
A/C Conversions	70	17	87	9.3	4.9	14.2
Refrigeration conversions	159	98	257	19.6	20.3	39.9
CFC114 A/C Conversions	5	97	102	31.6	178.0	209.6
Food pulper/grinder	0	74	74	0	4.6	4.6
Sewage pumps	14	1	15	27.1	3.0	30.1
Total	660	324	984	\$605.0	\$218.0	\$823.0

SPCE Program Ship Class versus Execution

The data in Tables 2 and 3 summarize the Navy plan for installing the equipment necessary to meet compliance requirements. Table 2 demonstrates that no equipment type is required on all 281 ships. Most active ships already had the required oil water separators, oil content monitors, and sewage pumps by the start of the SPCE in 1995, therefore the total requirements are very low.

Table 2. Ships Installation Complete by Class

<u>Equipment type</u>	<u>Auxilliary</u>	<u>Surface combatant</u>	<u>Amphib warfare</u>	<u>Mine warfare</u>	<u>Subs</u>	<u>Total</u>
Plastic waste processor	16	126	39	1	0	182
Pulpers and shredders	15	92	36	0	0	143
Oil water separators	3	5	19	1	0	28
Oil content monitors	9	21	20	5	0	55
A/C Conversions	13	34	23	0	0	70
Refrigeration conversions	17	102	21	11	8	159
CFC114 A/C Conversions	0	5	0	0	0	5
Food pulper/grinder	0	0	0	0	0	0
Sewage pumps	0	10	4	0	0	14

Table 3. Ships Installation Remaining by Class

<u>Equipment type</u>	<u>Auxilliary</u>	<u>Surface combatant</u>	<u>Amphib warfare</u>	<u>Mine warfare</u>	<u>Subs</u>	<u>Total</u>
Plastic waste processor	0	1	0	0		1
Pulpers and shredders	1	21	3	1	0	26
Oil water separators	0	1	1	0	0	2
Oil content monitors	0	3	2	3	0	8
A/C Conversions	2	0	0	15	0	17
Refrigeration conversions	4	24	12	4	54	98
CFC114 A/C Conversions	7	66	23	1	0	97
Food pulper/grinder	0	0	0	0	74	74
Sewage pumps	0	0	1	0	0	1

The remaining installations, shown in table 3 above, illustrate the compliance priorities of the program. The required compliance date for the food pulper/grinder on submarines is 2008. The Navy is using the CFC and Halon phase-out extension, and the DoD ozone depleting substance strategic reserve to extend the installation of conversion kits. These two programs account for 248 of the 265, or 94 percent of the remaining installations.

Appendix E. INSURV Program and Equipment Inspection Data

INSURV was originally established in 1868 to ensure that ships of the U.S. Navy were properly equipped for prompt, reliable, sustained mission readiness at sea. On August 5, 1882, Congress enacted legislation under section 7304, title 10, United States Code, (10 U.S.C. 7304), that established INSURV under statutory authority. It has been continuously operating under this authority since that date.

INSURV is required to evaluate the condition of Navy ships at least once every 3 years for the purpose of determining and reporting upon a ship's fitness for further service and those material conditions which limit its capability to carry out assigned missions. Additionally, INSURV is authorized to inspect two program areas: environmental compliance and Navy occupational safety and health. Inspection teams consist of INSURV assigned personnel, technical experts from Fleet Technical Support Centers, and independent contractors.

Oil Pollution Abatement

Table 1 contains data collected by INSURV demonstrating a continued high rate of failures in oil pollution abatement equipment. According to their analysis, failures are caused by procedural, human, and material factors. Procedural and human factors identified include incomplete or outdated logistics support, failure to complete planned maintenance according to schedule, and a lack of command emphasis on completing and maintaining certification requirements. The material factor contributing to equipment failure are deficiencies with certain models of oil content monitors.

Table 1. Oil Pollution Abatement Equipment Failure Rates					
<u>Calendar year</u>	1995	1996	1997	1998	1999
<u>Equipment type</u>	<u>(percent)</u>	<u>(percent)</u>	<u>(percent)</u>	<u>(percent)</u>	<u>(percent)</u>
Oil water separator	31	41	42	41	47
Oil content monitor	32	50	56	33	51

As part of the ongoing effort to support the INSURV boards, in FY 1998 and FY 1999 the Naval Surface Warfare Center, Carderock Division, Ship Systems Engineering Station collected and analyzed samples retrieved from oil water separators to determine effluent oil concentration and general system performance. Tables 2 and 3 summarize oil concentration analysis results.

Table 2. Average Discharge Oil Concentrations, FY 1998

<u>Ship</u>	<u>Type</u>	<u>ppm*</u>	<u>Ship</u>	<u>Type</u>	<u>ppm*</u>
AGOR-15	Auxiliary	261	LHD-5	Amphib warfare	209
AOE-10	Auxiliary	32	LHD-6	Amphib warfare	19
CVN-75	Nuclear carrier	15	LPD-14	Amphib transport	3
DDG-70	Destroyer	99	MHC-57	Minehunter	104
DDG-73	Destroyer	108	MHC-61	Minehunter	36
DDG-74	Destroyer	17			

*ppm – parts per million

Table 3. Average Discharge Oil Concentrations, FY 1999

<u>Ship</u>	<u>Type</u>	<u>ppm*</u>	<u>Ship</u>	<u>Type</u>	<u>ppm*</u>
AOE-4	Auxiliary	26	DDG-78	Destroyer	301/24
AOE-6	Auxiliary	42	FFG-50	Frigate	13
AOE-10	Auxiliary	77	LHD-6	Amphib warfare	20
CVN-69	Nuclear carrier	38	LSD-41	Dock landing	41
DD-991	Destroyer	11	LSD-46	Dock landing	309
DD-997	Destroyer	54	LSD-47	Dock landing	78
DDG-55	Destroyer	88	LST-1184	Tank landing	55
DDG-68	Destroyer	21	MHC-61	Minehunter	9
DDG-75	Destroyer	47	TAKR-301	Roll on/Roll off	84
DDG-76	Destroyer	41/26	TAKR-312	Roll on/Roll off	39
DDG-77	Destroyer	76			

*ppm – parts per million

The results summarized above measure apparent oil concentrations only. The test filters out the impact of detergents. The data show that in FY 1998, 82 percent of the ships inspected did not meet discharge standards of 15 parts per million. The

value for FY 1999 was 86 percent. Overall, 27 out of 32 ship's discharge had a oil concentration greater than 15 parts per million, with 6 greater than 100 parts per million.

Fouling of the parallel plates of the oil water separators, discovered during INSURV "open and inspect" inspections, was in some cases the cause of reduced performance. The level of fouling and contaminant build-up verified that ship's personnel were not cleaning the equipment as required. The cause of the oil build-up was the use of incompatible detergents and aqueous film forming foam during bilge tank cleaning, which prevent the separation of oil from the waste water.

Appendix F. Report Distribution

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Evaluation Team Members

The Contract Management Directorate, Office of the Assistant Inspector General for Auditing, DoD, prepared this report.

Paul J. Granetto
William C. Gallagher
LTC George P. Marquardt, USA
Joseph M. Kaseler
Nephateria N. McBride
Sylvia Powell